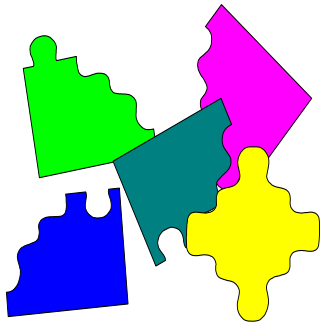
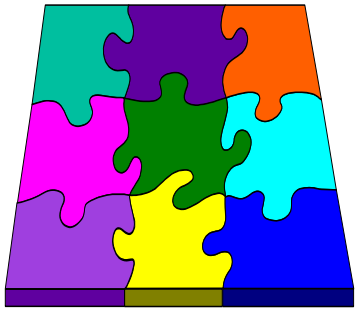
Incorporating Consumer Preferences Into Green Power Market Analysis





Renewable Energy Modeling Series

Washington, DC

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The Fallacy of Choice

- At home, you don't buy the cheapest wine, you buy things you don't understand for your children, you buy a car for its color, clothes for the fit, house for the location, and your friends tell me that you make really poor choices when buying their holiday gifts. Then you go to work and make optimal decisions based exclusively on the perfect knowledge of cost – and with unstated knowledge of the global impacts of your combined decisions over the next millennia.
- Do you think everybody you know makes choices using the same Jekyll & Hyde personality that you claim you have?

Modeling Renewable Energy

Modeling is an efficient means to test renewable energy policy without the risk of inappropriate, costly implementation.

- Are you doing the best job in simulating behaviors, responses, and impacts?
- Does the modeling adequately support and cultivate policy initiatives?
- Does the modeling help set goals, improve causal understanding, and delineate program value judgments from economics and engineering?
- Does the modeling describe all the important mechanisms for successful policy?
- ***Is the solitary, least-cost consideration satisfactory?****

*Marketing without a price change can increase sales by 50%. "The Role of Price Endings: Why Stores May Sell More at $49 than at $44." May 2000, Duncan Simester, Sloan School of Management, MIT

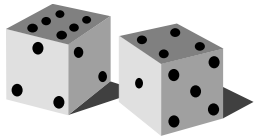
Methods for Modeling Market Choice

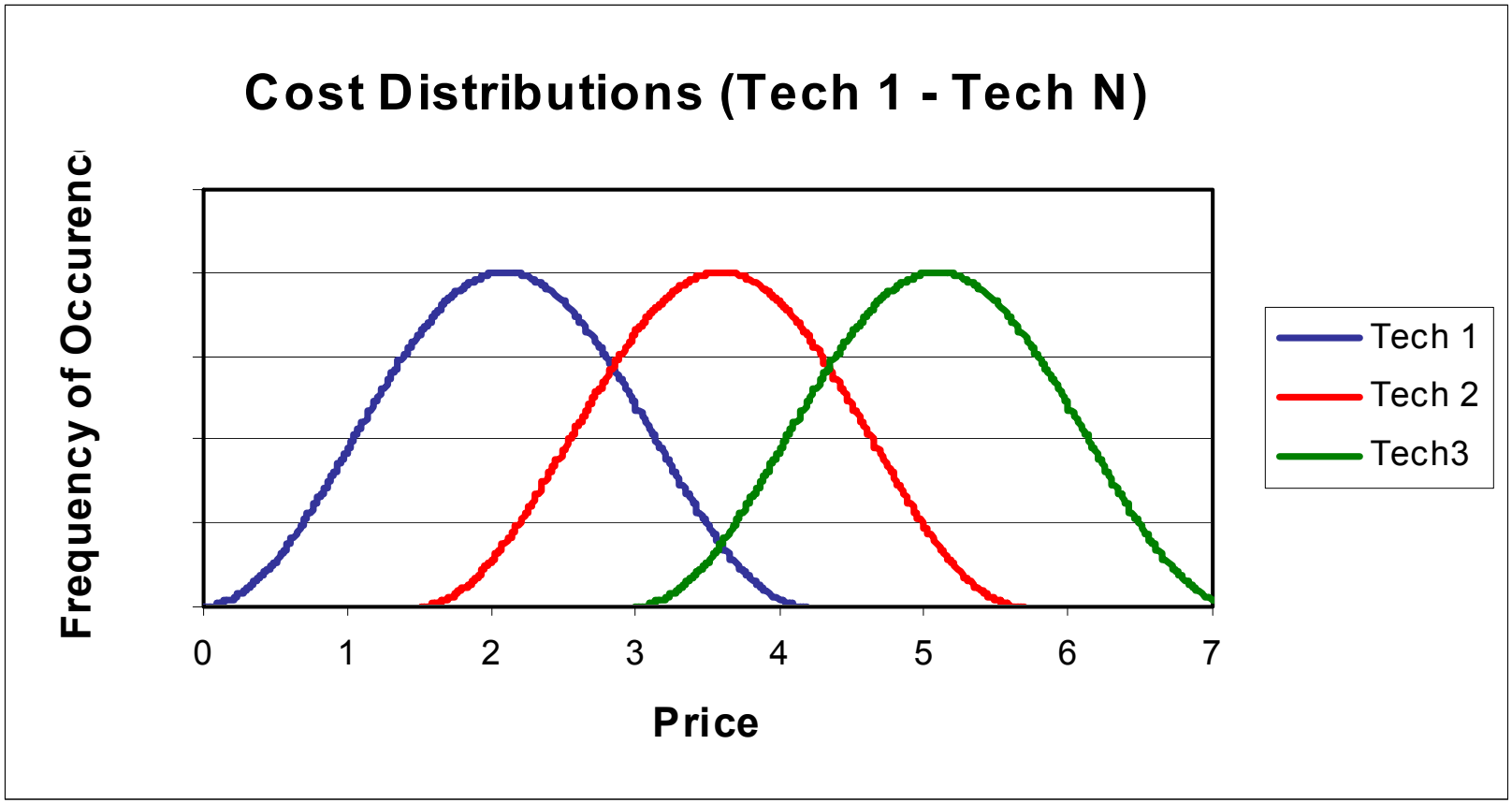
- Logistic Diffusion
  - » Simple logistic curve driven by time -- and maybe price conjecture
- Elasticity
  - » Econometric function of Price -- and maybe income
- Least Cost Curves
  - » Ordered sequence of engineering date using tenuous discount rates
- Non-Linear/Linear-Programming
  - » Optimization with perfect knowledge and equilibrium even under uncertainty
- Neural Networks
  - » Just a curve fit; void of policy information
- Genetic Algorithms
  - » A powerful search method that must assume policy impacts
- Qualitative Choice Theory (QCT)
  - » Behavioral response with price and non-price preferences, imperfect information, and uncertainty

Qualitative Choice Theory (QCT)

- Also called Random Utility Maximization (RUM):
  - » All entities make best perceived rational or irrational choice given the current information (bounded rationality).
  - » Developed by Daniel McFadden: 2000 Nobel Prize
- It is the conditional probability of choice given limited information and a variety of non-price influences.
- QCT is just modeling the human decision-response to (always) imperfect, uncertain information.
- Feedback logic compensates for estimation errors.
  - » Stocks and Flows: Flows are only caused by decisions; decisions are only based on stock-related information.
- It works: used in ENERGY 2020 for over two decades with robust accuracy and full policy capability.

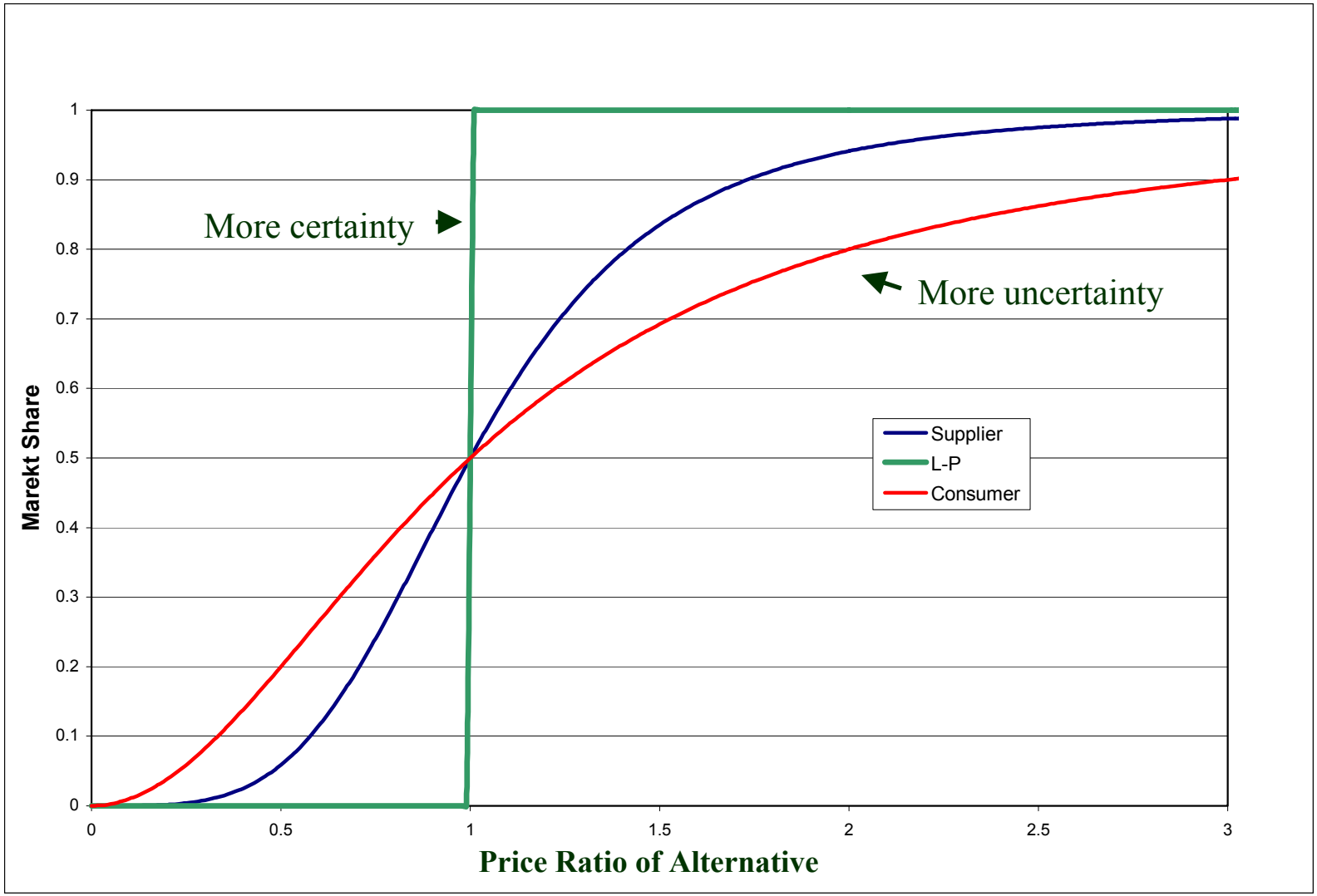
The Distribution of Choice (On Price Only)



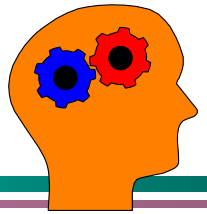


Integration over distribution gives market share (next slide)

Market Share and Uncertainty Impacts (Two-Choice Case)



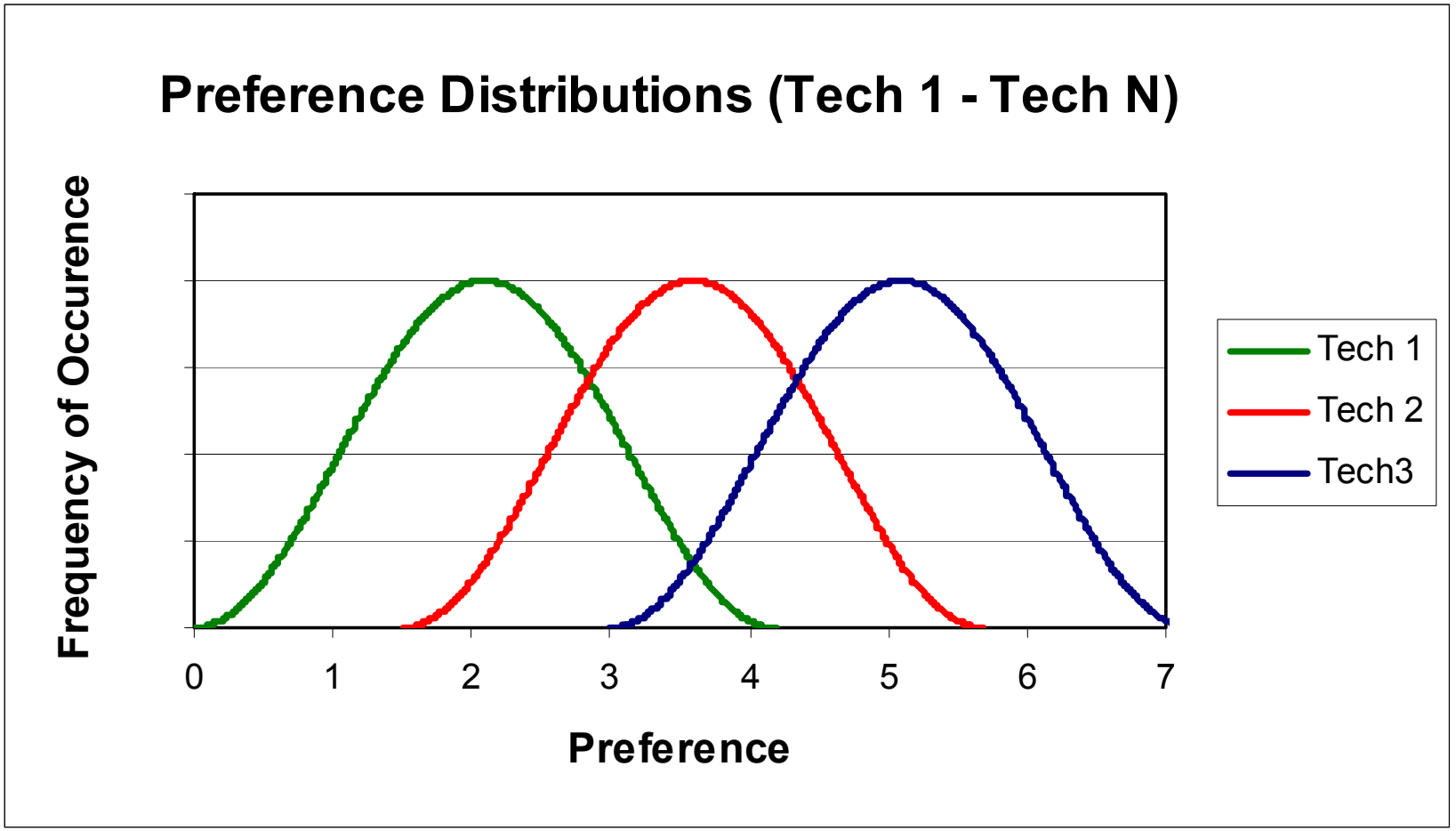
Preferences and QCT Response



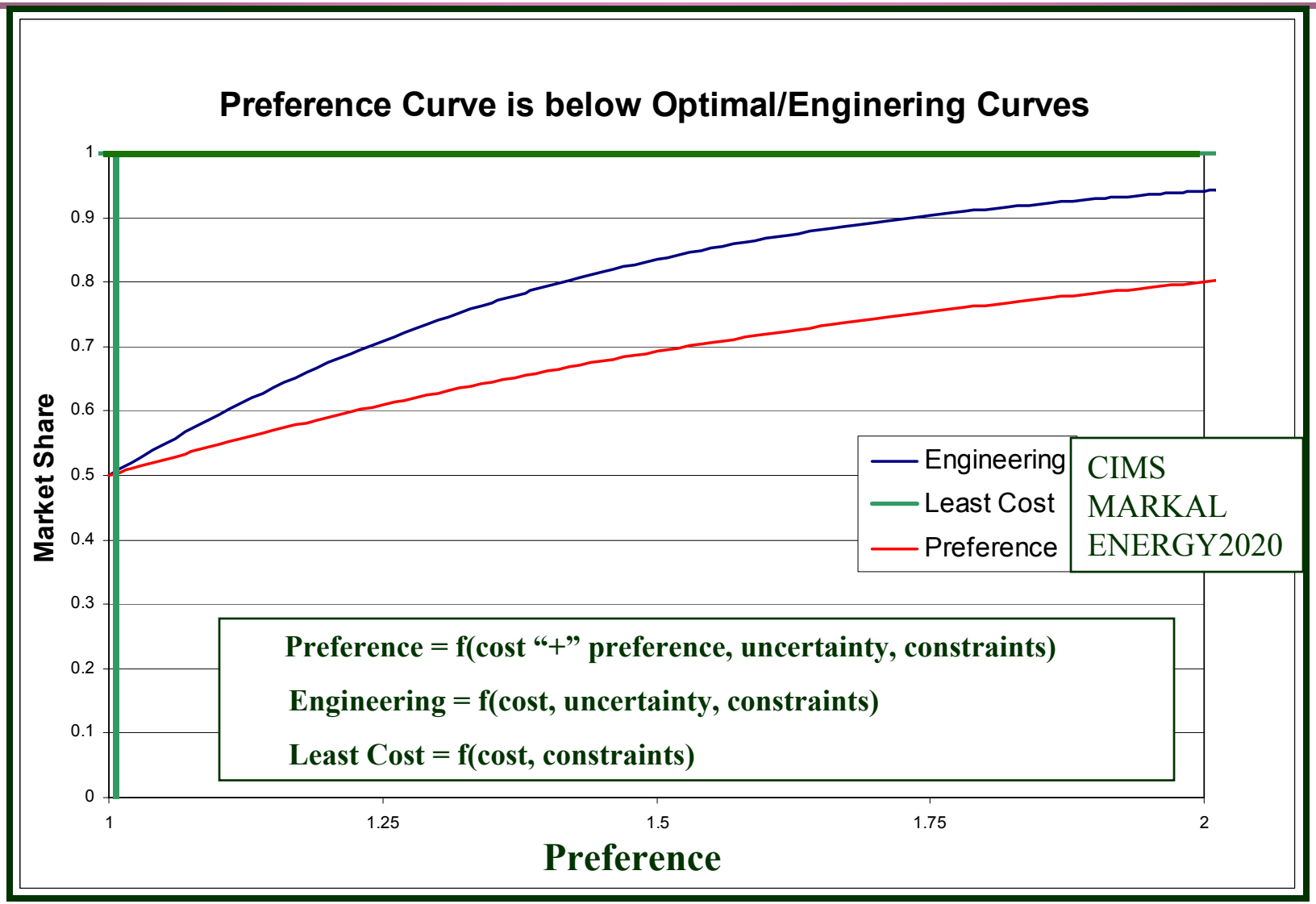
- Preferences can include income/status, market acceptance, awareness, “green value” safety, color, reliability, design, loyalty, etc.
- Preferences are affected by marketing, availability, risk, and volatility.
- Preferences can be robustly estimated from minimal, but relevant, survey **AND** decision data.

- Response diminishes at tails of distribution (e.g., price matters less).
- Most independent variables are logarithmic because only proportions are relevant, i.e., only ordinal (utility) information has meaning.

The Distribution of Choice (In Preference Space)



Preferences and Uncertainty Dilute Price Response



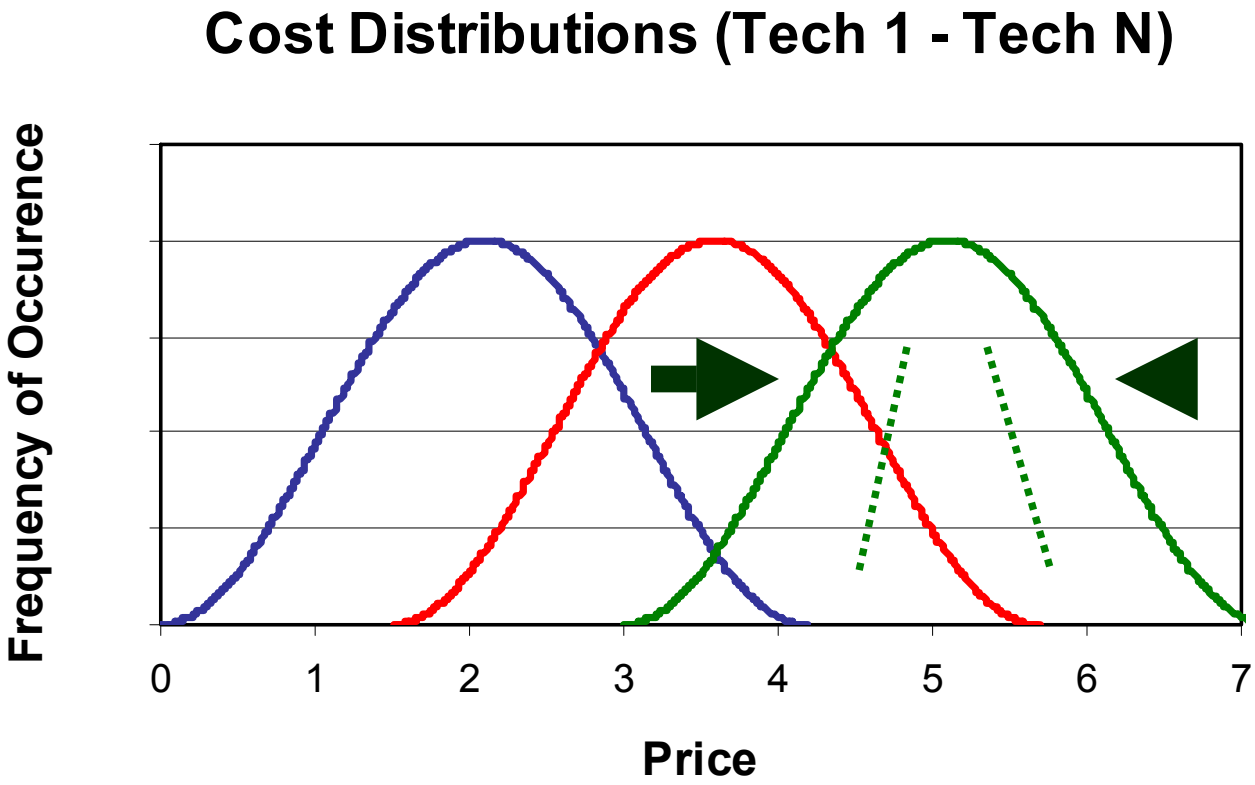
Decision-Makers And Decisions

- Consumer
  - Decision Factors: Income, tastes, perceptions, and price.
  - Decision Levers: Perceived value, marketing, peers (fashion)
- Electric Supplier
  - Factors: Need, cost, regulatory/market/technical risk & uncertainty
  - ~3X to ~10X more cost responsive than consumers.
  - Levers: Sameness, riskless, financial instruments
- Equipment Manufacturer
  - Factors: Technical characteristics, price, financial position
  - ~2X to ~3X more cost responsive than consumers.
  - Levers: Cash flow, ownership, capitalization
- Utility engineers/economists may perform “cost” analyses, but Board/Commission makes decision, where cost is only one input.
- Suppliers and institutions have more manageable preferences than consumers. Renewable goals may be limited by policy focus on consumers.

Changing Knowledge

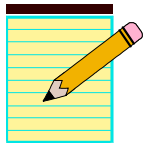
- Uncertainty more due to lack-of-effort to "know" than ability to "know."
- Increasing the knowledge may lose market share.
- Mandates (portfolio standards) primarily increase market size to produce learning-by-doing, economy-of-scale, **AND** market acceptance impacts. A mandate/law is new knowledge in the preference decision that compares utility of decision outcomes.

Losing Market Share via Information Programs



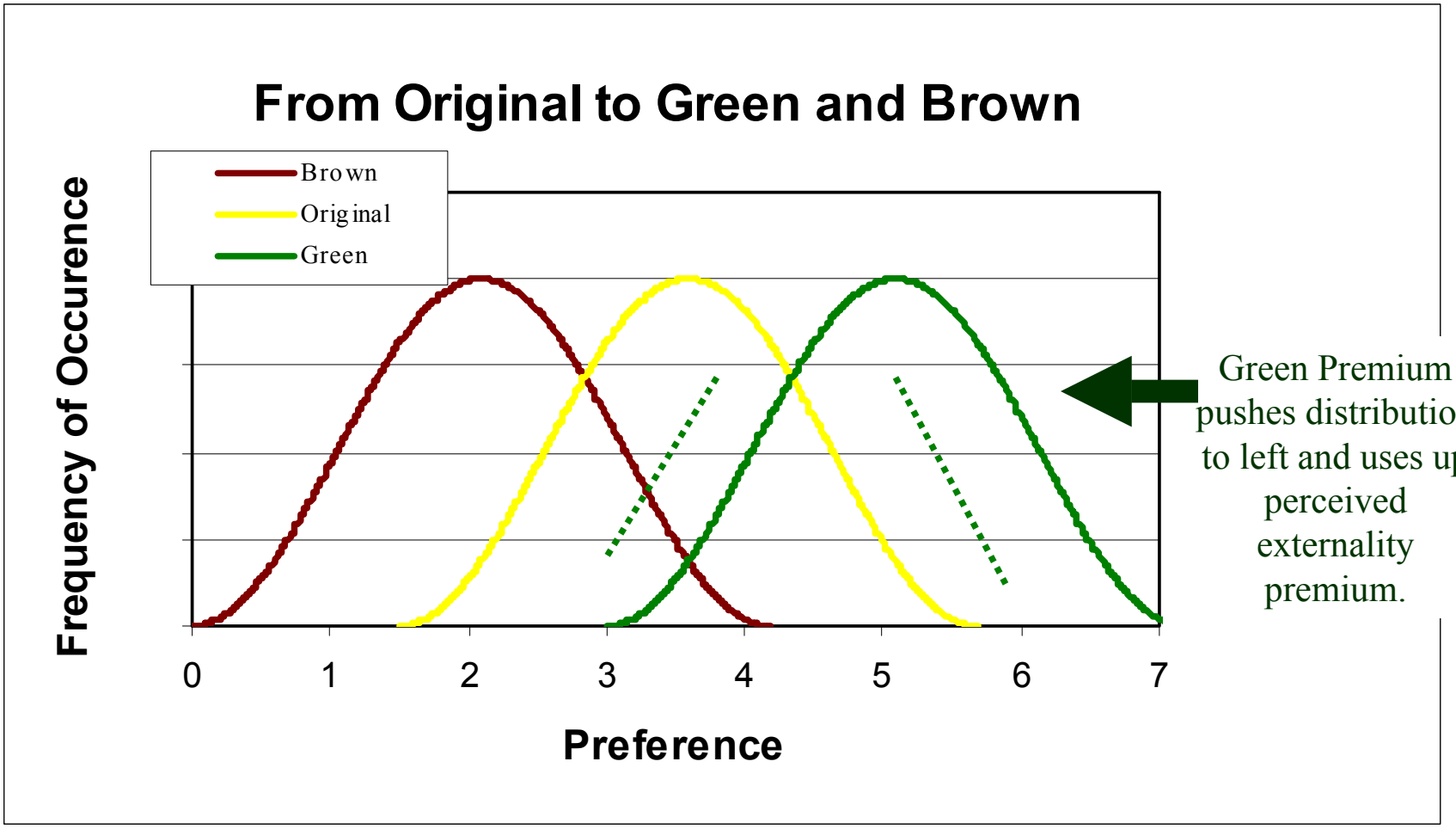
More Information Narrows Distribution and Reduces Overlap

Green Power Implications

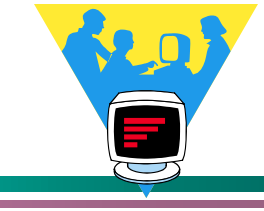


- Green Power adds a dimension to electricity **CONSUMER** choice.
- It is **DECISION** on utilization; an easily changed, volatile decision.
  - » It indirectly causes (forces) the utility to obtain renewable energy that indirectly causes manufacturers to produce it.
  - » Need to be explicit about the cascade of decisions and dynamics among distinctly different stakeholders.
  - » Canada rejected “Green Power” as a vehicle to achieve Kyoto Compliance in favor of direct subsidy of utility and manufacturer investments.
  - » Green Power is more PC than societal mandates, cheaper than a direct subsidy, less blatant than a fossil tax, but less efficient.
- QCT can back-out the perceived “externality” benefit of renewables – for GHG and sustainability.
- Green Power reduces the preference for renewable energy.

Green Pricing Reduces Market Share

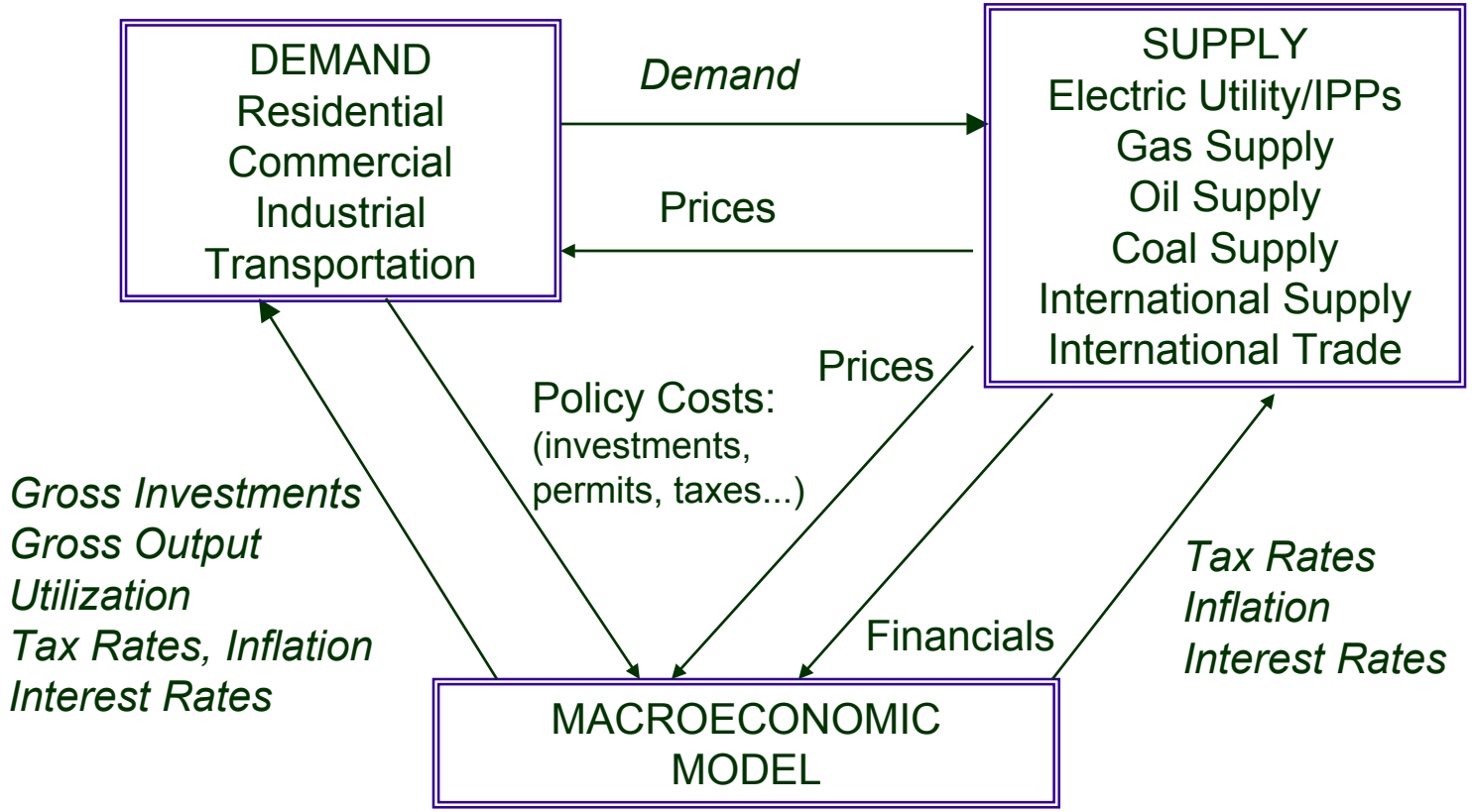


ENERGY 2020 Model



- N. American Jurisdictional Coverage - 50 US States, 13 Canadian Provinces, Limited Mexico, Limited ROW
- Sectoral Coverage - Demand
  - Residential (3 categories)
  - Commercial (15 categories)
  - Industrial (27 categories)
  - Transportation (45 modes by sector)
- Supply -
  - Electricity and Transmission (Deregulated/Regulated)
  - Simplified, Dynamic Oil, Gas, & Coal (Price and Production)
- Pollution -
  - Both Supply & Demand Sectors
  - Both GHG and CACs
- Annual Forecast/Validation (1985-2030): Calibrated To CEO/AEO
- Stocks & Flow Feedback Approach
- Imperfect Information And Uncertainty – Since 1978
- Company/Regional Planning And Policy in 20 Countries

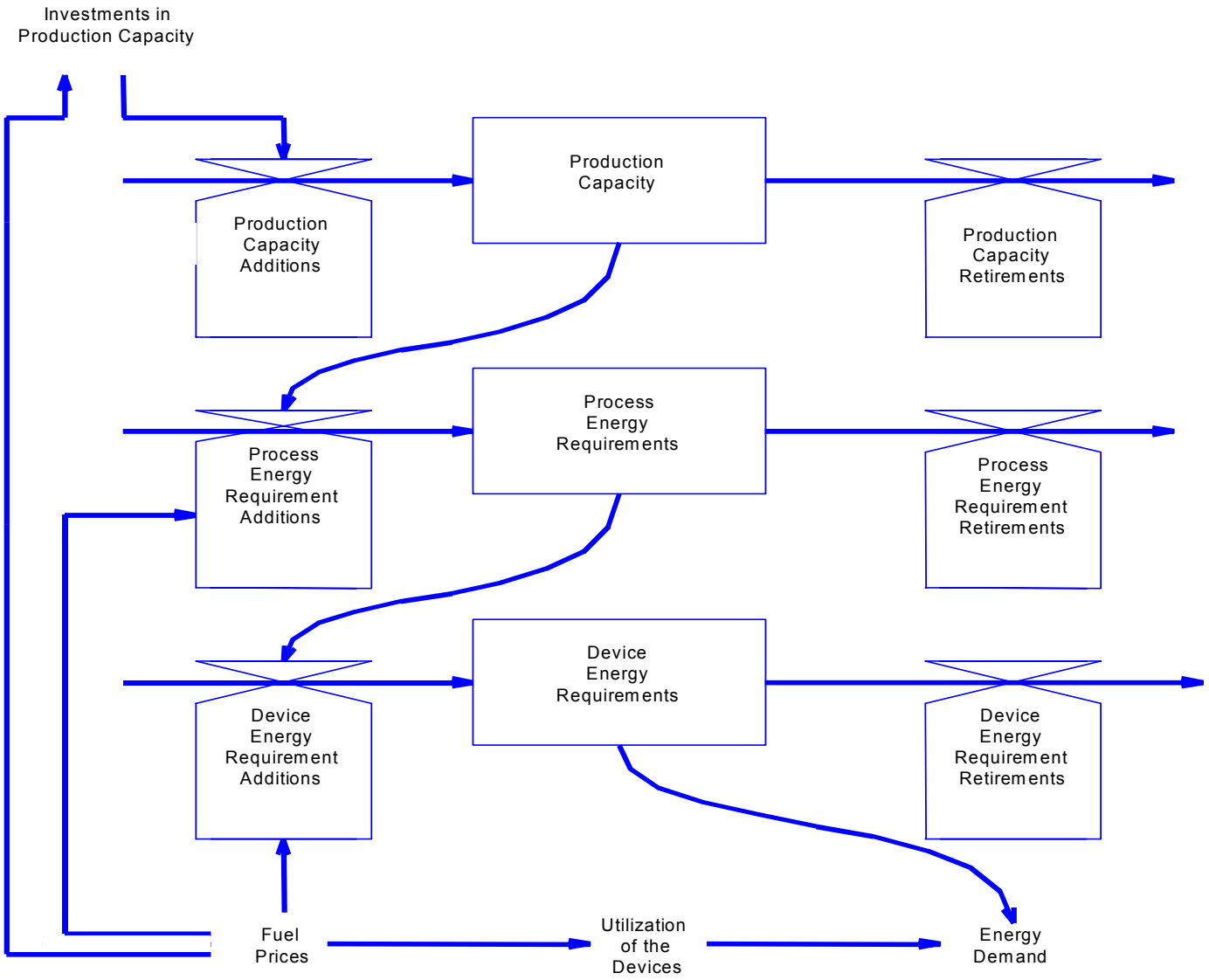
Energy 2020 Sector Relationships



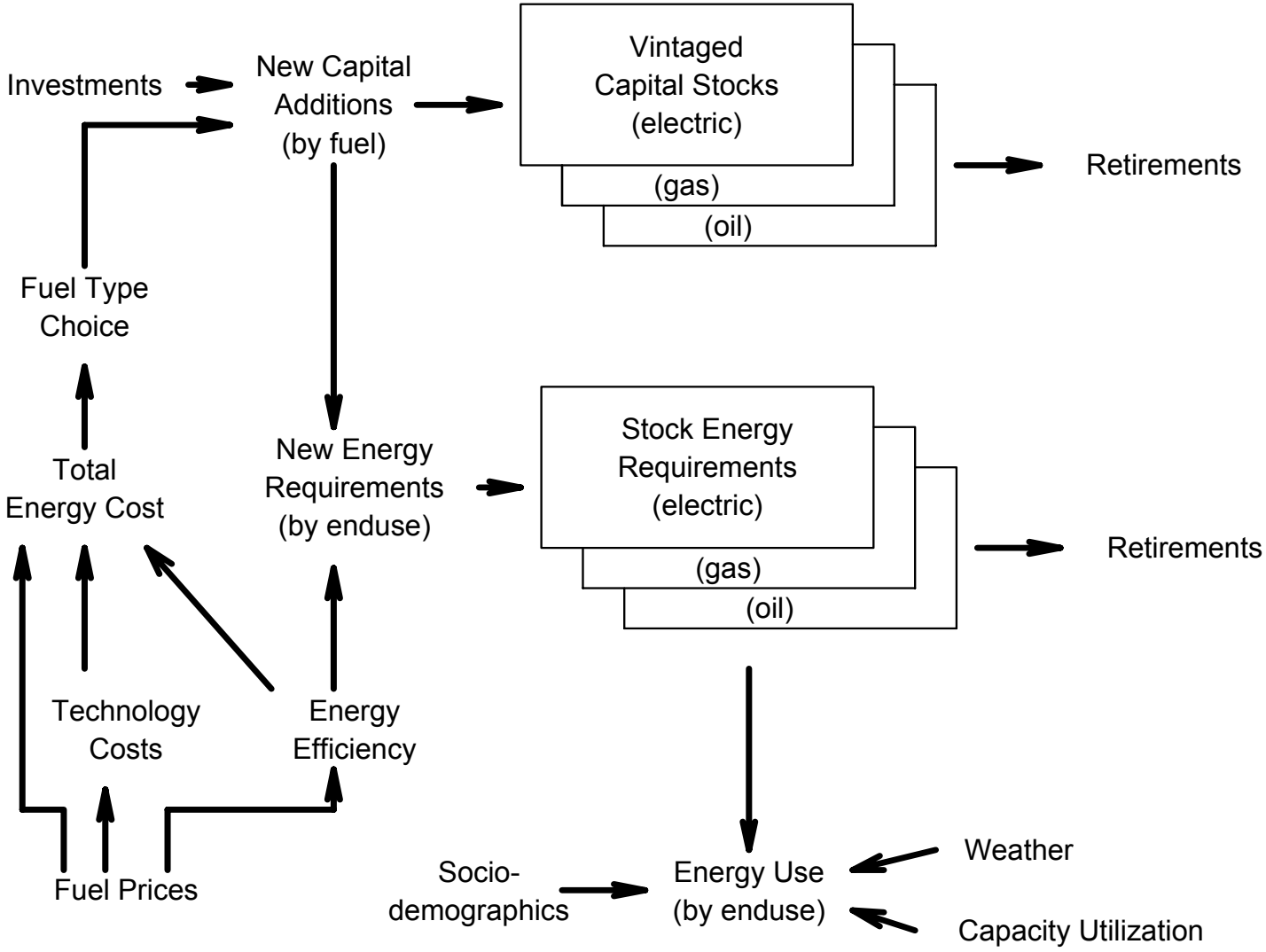
E2020 Fuel and End-Use Detail

- Fuel: Oil, Gas, Coal, LPG, Electricity, Biomass, Solar
- Retail/Bypass: Gas and Electricity
- End-Uses: Res., Com., Ind.
  - Space Heating, Process Heat
  - Water Heating
  - Other Substitutable
  - Refrigeration
  - Lighting
  - Air Conditioning
  - Motors
  - Other Non-Substitutable
- Feedstocks: Lubricants, Solvents, Asphalt, Chemicals (R,C,I)
- Cogeneration/Distr. Generation: Res., Com., Ind., Trans.

ENERGY 2020 Demand Stocks and Flows



QCT in E2020 Demand Dynamics



E2020 Electric Detail

- Complete Physicals and Financials by company (3500) and service area.
- Distribution, Retail, Transmission, Generation Business Units
- AC/DC/Path Load-Flow: Optimal Physical with Imperfect Operational
- 24 plant types (with multiple fuels)
- Deregulated/regulated markets by area (rules/gaming)
- Endogenous capacity expansion
  - » Based on Price, demand, or reserve margin.
  - » Internal forecast
  - » Imperfect market information
  - » Policy by mechanism

(Kyoto) ENERGY 2020 Generation

- Gas/Oil Peaking
- Gas/Oil Combined Cycle
- Gas/Oil Steam
- Coal 1989-2003
- Advance Coal
- Nuclear
- Base Hydro
- Peak Hydro
- Other Generation
- Biomass
- Landfill Gas/Waste
- Wind
- Solar
- Fuel Cells
- Pumped Hydro
- Low Head Hydro
- Wave
- Geothermal
- Other Storage
- Other/Coal 1984-1988
- Other/Coal 1979-1983
- Other/Coal 1974-1978
- Other/Coal 1969-1973
- Other/Coal 1900-1968

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